



Multisensor Inspection & Characterization Robot for Small Pipes (MICROSPI)



Developer: Lockheed Martin
Contract Number: DE-AR21-95MC32115
Crosscutting Area: Robotics

Deactivation & Decommissioning FOCUS AREA

Problem:

There is a need in the Department of Energy (DOE) to inspect the internal condition of piping and other inaccessible, hazardous, or restricted environments during deactivation and decommissioning (D&D) of unused facilities. Current approved methods for D&D of inactive facilities requires careful characterization of the building elements prior to cleanup. This is to ensure worker safety, to avoid inadvertent spread of contamination, and to enable waste separation. There are hundreds of miles of pipes at various DOE sites that have to be characterized prior to cleanup/disposal.

Solution:

Develop an operational system for real-time, multisensor characterization and mapping of small diameter (1") contaminated process pipes (MICROSPI). Specifically, the product of this effort will be a semiautonomous device with onboard miniature sensors and a remote operator interface with integrated data display capable of inspecting pipes for radiation, organics (solvents and

PCBs), and metals (mercury, lead, arsenic, etc.), and capable of mapping unknown piping runs from internal position data.

Benefits:

- ▶ Modular system, capable of carrying sensors for multiple applications
- ▶ Cost effective-modular detector elements are inexpensive
- ▶ Can usually inspect pipe interior; analyze for radionuclides, organics and heavy metals; and map unrecorded piping runs

Technology:

The pipe characterization system is composed of a pipe crawling vehicle, a very long, high-strength, multi-element tether, a tether management system, a remote instrument case, and a portable operator interface. The pipe crawling vehicle and its associated remote instruments are modular in nature. This is necessary for the system to navigate tees and elbows, but it is also convenient to tailor the inspection system to the task at hand. Different numbers and types of detector heads and mobility

segments can be combined to assemble customized systems.

The pipe crawler remote vehicle portion is composed of four sensor segments (composing 5 sensing functions) and two mobility segments (only one may be necessary). The diameter of all components is less than 0.75", or about the size of a finger. The length of the individual segments is less than 1.125". For some functions, two segments are required. Mobility actuation is based on Shape Memory Alloy actuators originally developed for ultralight satellite actuators.

The sensing functions included in the systems are the range of required characterization for D&D of 1" pipes. The miniature detectors and instrument designs are based on past work on interplanetary satellites where low power and automated data interfaces are required. As much of the instrument support electronics as possible are removed from the vehicle and installed in a support enclosure where the tether terminates. In some cases the sensor solution is well defined as for the visual inspection activities. In other cases, such as organic



characterization, selection of final components depends on further testing. In the case of organics, it seems reasonable to use UV spectroscopy to survey the presence of hydrocarbons since this is easily integrated.

Project Conclusion:

During Phase I, Lockheed Martin developed a conceptual design for the mobility system, which is a series of expanding bellows, and detection systems for radionuclides, organics, heavy metals, and visual (video) imaging. This phase was completed in March 1996. The reason the MICROSPI effort did not proceed into Phase II (Option 1) is because the need for this technology has not been adequately demonstrated and because of the associated high costs.

Other technologies capable of addressing pipe inspection have been successfully demonstrated including: the Pipe Explorer™, by Science and Engineering Associates, the PNEU-WORM, by Remotec Inc., and LVS Pipe Crawler System. The PNEU-WORM and LVS Pipe Crawler are commercially available. Hence, at an expected development cost of nearly \$3 million, MICROSPI could not be justified. If developed, the technology would potentially be of use to the DOE, possibly at Rocky Flats and/or Oak Ridge based on DOE contacts with Lockheed Martin. The need within the DOE complex is focused on drain lines, and the Pipe Explorer™ has proven itself in such applications. The MICROSPI, however, was expected

to have heavy metals and organics detection capability which the other competing systems lack.

Contacts:

Robotics and automation have been core technologies at Lockheed Martin for its aerospace and defense activities. Lockheed Martin is actively applying this technology base to DOE's needs. For information on this project, the contractor contact is:

Principal Investigator:

Mr. Eric Byler
Lockheed Martin
P.O. Box 179
Denver, CO 80201
Phone: (303) 971-5875
Fax: (303) 977-4739
E-mail: byler@den.mmc.com

DOE's Federal Energy Technology Center supports the Environmental Management - Office of Science and Technology by contracting the research and development of new technologies for waste site characterization and cleanup. For information regarding this project, the DOE contact is:

DOE Project Manager:

Dr. Harold D. Shoemaker
Federal Energy Technology Center
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
Phone: (304) 285-4715
Fax: (304) 285-4403
E-mail: hshoem@fetc.doe.gov

